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ABSTRACT

The effects of different conditions of peer interaction on the conservation judgments of first and second grade children were investigated. Children were subjected to either a control group situation or one of four types of peer interaction (cognitive conflict, social interaction, modeling, or cognitive dissonance) in which they were presented with incorrect information which conflicted with their prior incorrect beliefs. The reason for presenting incorrect information was to assess unambiguously the effects of peer conflict in promoting cognitive change. Subjects were assessed for (1) the number of response changes from pretest to posttest, and (2) changes in conservation scores from pretest to posttest on conversation of mass and length problems. Results indicated that, compared to control subjects, subjects in the four peer interaction conditions changed significantly more answers after the conflict exposure. Subject in all groups except the social interaction group changed their answers in the direction of the incorrect information presented in the conflict situation. Subjects in the social interaction group exhibited more total changes than any other group, and the changes were in the direction of conservation judgments rather than conflicting nonconservation judgments. (Author/SS)

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WHEN TWO WRONGS MAKE A RIGHT: PROMOTING COGNITIVE CHANGE THROUGH SOCIAL CONFLICT

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Peer conflict and interaction in small group settings have been shown in a variety of research studies to promote cognitive development. What remains unclear is what aspects of interaction between conflicting peers produce this cognitive growth. All prior research on this question has been flawed by a major confound which this study corrects; namely, in all variants of the peer interaction situation, the low achieving students are subjected to the correct information as well as the peer conflict. Thus, the cognitive growth cannot be attributed unambiguously to peer conflict effects.

In this study, children were subjected to one of four types of peer interaction (cognitive conflict, social interaction, modeling and cognitive dissonance) in which children were presented with incorrect information which conflicted with their prior incorrect beliefs. Any cognitive growth which results from this unusual pedogogical technique is attributable to conflict aspects of the peer interaction and not the information contained in it.

One source for understanding how children acquire knowledge is the cognitive developmental theory of Jean Piaget. He has proposed an equilibration mechanism to account for cognitive growth. In a recent discussion of the equilibration process, Piaget (1977) says that one source of progress in the development of knowledge is found in the "nonbalance" that forces a subject to seek new equilibriums but that while this imbalance may be essential, it cannot give rise to the content required for cognitive growth.

In a review of factors related to conservation acquisition, Smedslund (see Murray, 1972) concluded that "the occurrence of communication conflict is a necessary condition for individual decentration". Social conflict can be contrasted with those which stem from conflicts between the

individual and the environment or from conflicts between discrepant information in the task. Some authors (e.g., Strauss, 1974-75, Beilin, 1976) have concluded that although other conservation training techniques have had some success, the social conflict training studies have yielded the most consistent growth in experimental subjects.

However, a literature review revealed that nearly all social conflict studies provided the correct information or algorithm that by itself could have been used by the child to adequately solve the problem. Thus, it has not been clear whether social conflict or the information contained in it was responsible for the change in children's posttest scores, or if the effect was due to the combination of both conflict and content as proposed by Piaget.

To examine whether conflict lacking correct informational content was sufficient to generate cognitive growth, experimental subjects were subjected to one of four kinds of conflict that contained incorrect information that was contrary to their prior assertions about two conservation problems.

It was hypothesized that if conflict alone was responsible for the cognitive growth in past studies, the conflict groups would have significantly higher posttest scores than the control group. However, if as Piaget has argued, both conflict and content are necessary for growth to occur, then subjects would either show no change at all as a result of the conflict exposure or would change in the direction of the conflicting response.

METHOD

A pretest of nine conservation problems, including three length, three mass and three quantity tasks was administered to first and second graders. On the basis of their pretest scores, ninety-six subjects were randomly assigned to one of the five treatment groups. On a second day, the children were subjected to a conflict or control exposure. In each of the conflict situations, subjects were presented with responses to a conservation of mass and length problems, presented in random order, that conflicted with their initial judgment. For example, children who had asserted that the pancake had more clay than the ball, were presented with a response that the pancake had less clay than the ball.

Social Interaction Condition

In the social interaction condition (Murray, 1972) subjects (N = 38) were paired on the basis of their disagreement on one length and one mass task. Subjects were seated next to each other and told:

> Do you remember the other day I asked you some questions? When I went home and thought about what you told me, I was confused. I had two sticks that were the same length, like this, remember, and then I took one stick and moved it like this (transformation). (To one child): Do you remember what you said when I did that?. . . (To other child): And do you remember what you said?. . . You don't agree, do you? I didn't understand how the sticks could be both longer and shorter. What I'd like you to do today is talk about this and agree on one answer between you. Is that stick longer, shorter or the same length as the other one? I will go to the other side of the room, and I won't say anything while you are talking with each other. When you have finished talking, decide who will give your answer, okay? Do you have any questions? Remember, talk it over until you agree on one answer.

These instructions were repeated for a second task after agreement was reached on the first task. The entire social interaction episode was videotape recorded.

Modeling Condition

Subjects (N = 19) in this group were asked to listen to a peer respond to two problems. Subjects heard judgments and reasons of the same type presented in the interaction condition for any length and mass task that conflicted with their responses in the pretest. For example, if subjects thought the transformed rod was longer, they watched someone judge that it was shorter and heard a nonconservation reason for that judgment. Subjects who performed the task for the model subjects were children in either the pretense or control groups.

Pretense Condition

Subjects (N = 19) in this group were asked to pretend the opposite of what they asserted in the pretest for a length and a mass task using the dissonance procedure from the Murray, Ames and Botvin (1977) study. The experimenter said:

> Hi, when you were here before you told me that when I did this (transformation) this rod would be longer (or shorter) than this one. Remember? Okay, this time we're going to play a little game. I'm going to bring another person in to listen while we do the same thing we did before, only this time I want you to pretend that after I do this (transformation) the rod is shorter than this one. You know how to pretend, don't you? Even though you really don't believe it, I want you to tell me that the rod is shorter when I move it and when I ask you why, I'd like you to tell me that it's because it sticks out over here (or it's far back here). Do you think you can remember that? Let's try it.

Instructions were repeated for the other problem and practiced. After a practice session the child performed both tasks in front of a peer.

No subject failed to give the response desired in the experimental session and subjects typically required only one practice session to master their pretense.

Information Condition

Subjects (N = 19) were presented individually with two problems; one length and one mass, randomly selected from those they initially failed, following a procedure used by Murray (1968). In each case after performing the transformation and reminding subjects of their initial judgment, the experimenter switched the sticks, for example, so that the one previously in the upright position was placed horizontally and the one placed horizontally switched to an upright position. The question of whether the sticks are now longer, shorter or the same was repeated. The experimenter then said: "So this was the longer stick before and now it's shorter, is that right?" The transformation was done three times to match the average number of experiences other experimental subjects had in seeing the manipulation done. The same procedure was followed with a randomly selected mass task.

Control Condition

Subjects (N = 19) in the control condition were reminded of their answers to two selected tasks of the set used for the other subjects and were asked to perform the problems in front of another child, "so (Billy) can see what you think about these things".

Immediately after the experimental session and again after a four week delay, all subjects were tested alone on the nine conservation items. The experimental session was videotaped. The pretest and posttests were audiotaped.

Scoring of Conservation Items

In scoring the items, one point was given for each conservation judgment and one point for an appropriate supporting reason for a possible total score of 18. Twenty-five percent of the pretest audiotape protocols were randomly selected for scoring by another rater. The percentage of agreement on whether subjects' responses were conservation judgments was .99. In only two cases out of 165 reasons coded, was a reason judged adequate by one rater and inadequate by the other.

Analysis of Social Interaction Episodes

Following procedures adapted from Miller and Brownell (1975) and Brenneis' and Lein (1977), the videotapes of the pairs of social interaction subjects were coded into categories that included: (1) kind and number of assertions (pretest, conservation or contrary), (2) type of assertion made first in the interaction sequence, (3) number of statements of agreement or negations of peer's assertion, and (4) number of reasons provided for assertions and incidence of pointing during the interaction.

RESULTS

The main research issue addressed by this study is whether conflict provides sufficient disequilibrium to induce cognitive change. To answer this question, subjects in the four conflict groups were compared to the control group with respect to two dependent variables: first, the number of response changes from pretest to posttest and second, changes in conservation scores from pretest to posttest.

Change Score Analysis

Analyses of variance were conducted separately for the number of nonconservation changes, conservation changes and total changes for each experimental group. The mean number of changes in each category across experimental groups is shown on Table 1. One way analyses of variance revealed no significant differences across groups for nonconservation changes in posttest 1 ($F(4,109) = 1.93$, $p > .05$) and posttest 2 ($F < 1$). Alpha was set at .05 test-wise for this set of analyses to increase the possibility of detecting differences of interest.

There was a significant difference in the number of conservation changes on both posttests (posttest 1, $F(4,109) = 5.39$, $p < .001$, posttest 2, $F(4,109) = 5.02$, $p < .01$). Post hoc tests using the Neuman-Keuls procedure were conducted to compare the posttest means for all groups (Keppel, 1973). On both posttests the social interaction group was different from all the other groups ($p < .05$) and the other groups were not different from each other.

On total changes (to conservation or to a different nonconservation response) there was a significant difference between experimental groups for posttest 1 ($F(4,109) = 5.62$, $p < .001$) and for posttest 2 ($F(4,109) = 3.47$, $p < .02$). Here the post hoc Neuman-Keuls analyses between all posttest means revealed a more complex picture. For posttest 1 all contrasts were significant ($p < .05$) except between the means for the information and pretense groups. On posttest 2 there were no differences ($p > .05$) between the following adjacent pairs of means: control and model, model and pretense, pretense and information. All other comparisons were significant ($p < .05$). The mean number of changes in the social interaction group was significantly different from all other group means for both conservation changes and total changes.

Table 1

Mean Changes (and Standard Deviations) per Subject from Pretest to Posttest on Nine Conservation Items

Posttest 1

Kind of Change	Experimental Group: Social Interaction		Pretense		Model		Information		Control	
Nonconservation	1.68	(1.30)	2.42	(1.54)	1.84	(1.01)	2.31	(1.33)	1.52	(1.22)
Conservation	2.11	(2.45)	.68	(1.42)	.47	(.77)	.74	(1.19)	.37	(1.01)
Total	3.79	(1.85)	3.11	(1.91)	2.32	(1.20)	3.05	(.91)	1.89	(1.29)

Posttest 2 (1 month)

Kind of Change	Experimental Group: Social Interaction		Pretense		Model		Information		Control	
Nonconservation	1.63	(1.39)	1.88	(1.15)	2.00	(1.03)	2.31	(1.35)	1.69	(1.74)
Conservation	2.25	(2.90)	.75	(1.34)	.25	(.45)	.63	(1.09)	.38	(.72)
Total	3.88	(2.46)	2.63	(1.75)	2.25	(1.06)	2.94	(1.53)	2.06	(1.61)

Note: Total possible changes = 9.

These contrasts allow the creation of a hierarchy of treatment effectiveness. The control subjects in all but one case made the fewest changes of all. While social interaction subjects overall made the most total change, that was due to their large number of conservation changes. Total Change Score analysis revealed that the pretense and information treatments appear to be less effective than the social interaction treatment but more effective than the model and control conditions.

Postscore Analysis

While one question of interest is the amount of change produced by the experimental manipulation, the primary purpose of the study was to investigate whether any of the treatments was sufficient to bring about cognitive growth as measured by performance on the conservation items. To answer this research question, the data were analyzed to compare posttest scores for judgments and reasons on the nine conservation items.

Because of the unexpected significant grade effect in a regression analysis and the significant F statistics for the analysis of pretest score variance, posttest score analyses were done as a 5 x 2 factorial analysis of covariance (Finn, 1974) with pretest score entered as the covariate. This analysis revealed both a significant treatment group effect ($F(8,168) = 3.39$, $p < .0013$) and grade effect ($F(2,84) = 4.04$, $p < .02$) but a non-significant interaction ($F(8,168) = 1.15$, $p > .05$). Means and standard deviations are presented in Table 2.

Several *a priori* comparisons were made in this analysis. All experimental groups were compared to the control to test the first research hypothesis. In addition, all treatment groups were tested against the social interaction group.

The same differences between groups were significant for Posttest 1 and Posttest 2. Social interaction subjects' posttest score means were significantly different ($p < .001$) from those of the model, information and control subjects. Second graders had significantly higher posttest scores, even when pretest score was controlled. It is not clear why the social interaction versus pretense comparison did not reach significance, since the mean was lower than the information group. Possibly the higher variance in the grade 1 pretense group was responsible for the lack of significant effect.

The treatment condition that appears to violate this pattern is the one in which subjects observed a model given an opposite but still incorrect conservation response. There, the second grade pattern appears different from all the other conflict groups as well as the control group.

Social Interaction Analysis

The preceding results suggest that acquisition of conservation occurred primarily for subjects exposed to the social interaction conflict. The next section will present the results of the analysis of the videotape sequences for those subjects.

Using social interaction pairs as the unit of analysis, a product-moment correlation was calculated between posttest scores for 16 pairs of subjects who participated in both posttest sessions to test for a relationship between their posttest scores. The results were all significant at $p < .01$ (Posttest 1, Total Score, $r = .727$, Posttest 1, Judgment Only, $r = .681$, Posttest 2, Total Score, $r = .724$, and Posttest 2, Judgment Only, $r = .701$) suggesting that both partner's posttest scores varied together.

Table 2

Mean Conservation Total Scores (and Standard Deviations) for Experimental Subjects by Grade and Conflict Group

Grade 1

Trial	Experimental Group: Social Interaction		Pretense		Model		Information		Control	
Pretest (0-18)	.38	(.77)	1.08	(.79)	.50	(.90)	1.50	(1.31)	.25	(.62)
Posttest 1 (0-18)	3.21	(4.75)	.92	(2.61)	.83	(1.27)	.33	(.65)	.58	(.90)
Posttest 2 (0-18)	3.04	(5.58)	.83	(1.75)	.67	(.89)	.67	(.78)	.67	(1.23)

Grade 2

Trial	Experimental Group: Social Interaction		Pretense		Model		Information		Control	
Pretest (0-18)	1.25	(1.58)	1.75	(1.26)	1.75	(.50)	1.25	(1.89)	.75	(.50)
Posttest 1 (0-18)	8.25	(4.98)	3.75	(5.56)	.50	(1.00)	4.50	(4.43)	2.00	(4.00)
Posttest 2 (0-18)	8.13	(4.26)	3.00	(4.76)	.75	(.96)	3.75	(5.68)	2.00	(2.71)

Note: Score range = 0-18 (1 point for a conservation judgment plus 1 point for a correct justification.

There were 24 grade one subjects in the social interaction group and 12 grade one subjects in each of the other groups. There were 8 grade two subjects in the social interaction group and 4 grade two subjects in each of the other groups.

Subjects were separated into groups on the basis of whether the interaction pairs came to a conservation or a nonconservation agreement about the problem. The mean for subjects who made at least one conservation agreement (14 subjects) was 2.36 (out of 4 possible points) compared to a mean of .41 for the 24 social interaction subjects who did not make a conservation agreement. This difference was significant by a t test (t (36) = 31.37, $p < .001$) suggesting that an important factor in subsequent conservation was yielding during the interaction situation to a judgment that the amount of length is the 'same' after the transformation.

Additional analyses addressed these questions: How did the arguing take place? Was there a dominance factor such that subjects yielded on both problems or on none? There were 19 pairs in the study. Twelve pairs gave only nonconservation agreements. Of those, for six pairs one subject yielded twice and the other did not yield on either problem. In six pairs each subject yielded on one problem only (a trade-off situation). A sign test revealed that more second graders used this strategy than would be expected by chance. For the seven pairs who made at least one conservation agreement, four pairs gave only one conservation agreement and three pairs gave conservation agreements for both the problems.

While the score on posttest 1 obtained by the six nonyielders was the lowest of all the social interaction subjects (see Table 3), there was not a significant difference between that mean and that of the six yielding (to other nonconserver judgments) subjects. As might be expected, the posttest scores of the subjects who made conservation agreements as a result of the interaction were higher than those who did not, but again there was no significant difference between subjects who made two conservation agreements and those who made one nonconservation and

one conservation agreement. Posttest 1 scores were used for this analysis to utilize data from all 19 pairs in the study.

The social interaction subjects were separated into two groups; one group was exposed to a conservation judgment during the interaction situation, and the other exposed only to other nonconservation judgments. Posttest 1 scores for these two groups of subjects are shown in Table 4. A two-way analysis of variance revealed a significant difference between those who got conservation information compared to those who did not (F (1,34) = 17,06, $p < .001$). There was also a significant grade effect (F (1,34) = 5.38, $p < .05$) but the test of the interaction of grade and information was not significant. The generation of conservation information during the interaction sequence resulted in one or more conservation agreements between the peers. The postscore means for those subjects who did generate conservation information was 5.37 and 11.50 suggesting that the information was generalized beyond the two problems included in the conflict session.

Table 5 contains a list of the measures taken from the analysis of the social interaction sequence and the means and standard deviations for the different categories. Of the bevaviors categorized in the social interaction sequence, only "pointing" had a mean of over one (M = 1.53 for the length problem and M = 1.16 for the mass problem). Overall, the average number of assertions of any kind made was 1.46. Very few children used the communication strategies of negating what their peer had said (M = .07) or asking for agreement (M = .09). However, children did tend to agree with the peer's assertion (M = .54) and sometimes gave a reason to accompany their assertion (M = .47).

A sign test was used to see if categories were used more or less on the first or second problem. There was no significant difference.

Table 3

Means and Standard Deviations of Posttest Scores for Social Interaction Subjects by Agreement Conclusion and Judgment

	Interaction Agreement					
	Non-Yield on 2		Yield on 1		Yield on 2	
Judgment						
Nonconservation	1.67	(1.51)	3.16	(4.11)	3.50	(5.50)
Conservation	--	--	5.75[b]	(7.52)	8.00	(5.37)

[a]N = 38
[b]The other was a nonconservation judgment.
Scores from Posttest 1

Table 4

Means and Standard Deviations of Posttest Scores for Social Interaction Subjects by Conservation Information and Grade

Grade	Information	
	Conservation	Nonconservation
1	5.37 (5.99)	1.90 (3.39)
2	11.50 (4.28)	3.25 (3.95)

Table 5

Means and Standard Deviation of Measures Taken from the Conflict Sequences of Social Interaction Subjects

Measure	Mean	Standard Deviation	% Using Category
Pretest Assertions	.67	1.07	74
Contrary Assertions	.58	1.10	47
Conservation Assertions	.21	.66	21
First Assertion-Pretest	.22	.42	42
First Assertion-Contrary	.14	.35	29
First Assertion-Conservation	.12	.32	18
Peer Negations	.07	.30	11
Point to Objects	1.34	1.19	87
Gives Reason	.47	1.01	37
Agrees With Peer	.54	.77	63
Asks for Agreement	.09	.33	16
Concludes Discussion	.48	.50	66
Gives the Agreement Response	.54	.50	68
Changes for Agreement	.62	.49	76
Gives Reason in Agreement	.45	.50	58
Conservation Agreement	.24	.43	37

There was also no significant difference for the length and mass problem. Other findings were that there was no correlation between making the agreement statement and making the first statement during the interaction sequence, an additional suggestion that the interaction sequence was not simply a matter of one peer being the dominant member of the pair. There was no significant correlation between making the first judgment and "giving in" in the agreement phase. Changing during the agreement phase was significantly correlated with changing posttest judgment, $r = .616$, $p < .05$.

DISCUSSION

Relationships Between Results and Predictions

The results of this investigation will be discussed by relating them directly to each of the research hypotheses and then suggesting what general conclusions might be drawn from the study. The first hypothesis stated that children exposed to social conflict situations without the presentation of correct information would change their answers to conservation questions. The results of the change score analysis support that prediction. Compared to control subjects, experimenter subjects changed significantly more answers after the conflict exposure.

In general, the changes were in the direction of the content presented in the conflict situation as in previous studies. The conflicting information determined the outcome for pretense, model, and information subjects. However, the social interaction condition yielded a

different pattern of changes. In addition to having more total changes than any other group, the changes were in the direction of cognitive growth as predicted by the first hypothesis. The social interaction subjects generated new content (conservation assertion and agreements) that they generalized to other problems and provided a stable change to more conservation responses.

The second research hypothesis predicted differences in experimental effect among the various social conflict groups. The results of the study showed that social interaction and pretense groups showed more change than subjects in the model, information or control groups. However, there was a qualitative difference in the changes shown for the social interaction and pretense subjects. In the social interaction group, the majority of changes were to conservation judgments rather than to the conflicting nonconservation judgment. The apparent reason for this is that the content for at least sixteen of the social interaction subjects was a conservation assertion made during the discussion and agreement phase. Thus, conservation information had an impact on subsequent performance on conservation items and "yielding" affected cognitive growth even if the subject yielded to another nonconservation judgment. Those subjects who maintained their initial assertion throughout the interaction had the lowest posttest scores.

General Conclusions

It is not a new idea to suggest that cognitive conflict may be responsible for the acquisition of conservation in training studies and triggers the kind of cognitive reorganization that results in subsequent cognitive growth. Research by Smedslund was among the first to attempt to

intervene in the conservation acquisition process. In one of his earliest studies of that issue, Smedslund (1961a) proposed cognitive conflict as the mechanism of equilibration. In that paper he says (page 83):

> A common source of conflict lies in the standard questions of the pre- and posttests; 'Do you think this one weighs more than, the same as, or less than that one?' The long reaction times, the 'looking back and forth', and occasional signs of tension, indicate that this is indeed a situation of inner conflict.

In a later study (1961b) Smedslund attempted to induce conservation by providing practice in conflict by deforming an object and making simultaneous additions to or subtractions from that same object. This strategy proved more effective than external reinforcement in generating cognitive growth. However, subsequent attempts to link conflict, and especially social conflict, to the equilibration process did not result in as much progress since Smedslund's first research as one might have expected.

Piaget (1977) suggested that the equilibration process utilizes conflict and content. This investigation substantiated that assertion; the content contained in the conflict exposure determined that outcomes for most subjects. There was significant difference in change scores between each conflict group compared to the control group, similar to previous social conflict studies which presented conservation judgments to nonconservers.

However, the data suggest that a single mechanism cannot account for cognitive change in social conflict situations as Botvin and Murray (1975) suggested. The conflict provided in the social interaction exposure resulted in quantitatively more change than the other exposures, but more importantly, yielded a different kind of change, namely, to

conservation judgments. However, higher posttest scores were obtained by second graders in all conditions. For the social interaction subjects, the difference seems to be due to the conservation content that emerged during the interaction. But this content was not explicitly a part of the second graders' exposure and cannot account for that effect.

Cognitive growth in these situations that provided a contradictory assertion but not the correct judgment and justification for the conservation problem did limit subjects' growth. Second grade social interaction subjects made about half the growth available to them which is what conservation training studies have typically reported (Murray, 1978) but the results were depressed for the first grade social interaction subjects and for the second graders in the other conflict exposure groups. Thus, the results suggest that the content aspect is an important part of the equilibration process as argued by Piaget (1977).

In sum, the results of this study point up the dynamics of cognitive restructuring and how social ocnflict can affect that restructuring. The results also suggest that correct content and reasons are not necessary for the generation of the answers and justifications that index cognitive growth. The 'content' Piaget describes may then only be that someone else has a different belief and that the problem deserves some analysis and thought.

However, although this investigation demonstrated that social conflict can generate cognitive change and that social interaction can result in cognitive growth, it was not able to reveal exactly what aspects of the social interaction are responsible for the growth.

Further research is needed to delineate more specifically those social conditions under which "two wrongs make a right" to lead to cognitive growth.

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